electrometer needle came to rest; the result was that the residual charge under these circumstances did not exceed 3 per cent. of the original charge, also that it mattered not whether the discharge lasted $\frac{1}{17000}$ second or $\frac{1}{80}$ second. These experiments suffice to show that neither of the above suppositions accounts for the facts.

I have repeated my own experiments with the guard ring condenser, but with a more powerful battery, and with a new key which differs from the old one inasmuch as immediately after the condensers are connected to the electrometer they are separated from it. In no case do I obtain results differing much from those I had previously published.

Lastly, a rough model of the five plate induction balance used by Mr. Gordon was constructed, but arranged so that the distances of the plates could be varied within wide limits. So far as instrumental means at hand admitted, Mr. Gordon's method was used. A plate of double extra dense flint and a plate of brass were tried. In the first, by varying the distances of the five plates, values of K were obtained ranging from $1\frac{1}{4}$ to $8\frac{1}{4}$, with the latter values from $\frac{1}{10}$ to 3. It is clear that the five plate induction balance thus arranged cannot give reliable results.

The explanation of the anomaly, then, is that the deviation from uniformity of field in Mr. Gordon's apparatus causes errors greater than anyone would suspect without actual trial. It is probable that the supposed change of electrostatic capacity with time may be accounted for in the same way.

IV. "The Cochlea of the *Ornithorhynchus platypus* compared with that of ordinary Mammals and of Birds." By URBAN PRITCHARD, M.D., F.R.C.S., Aural Surgeon of King's College Hospital. Received November 9, 1880. Communicated by Professor HUXLEY, Sec. R.S.

(Abstract.)

General Form of the Cochlea of the Duckbill or Ornithorhynchus.

This cochlea consists of a somewhat curved tube, about a quarter of an inch (6·3 millims.) in length, and one-twentieth of an inch (1·26 millim.) in diameter, projecting forwards from the cavity of the vestibule and embedded in the substance of the petrous bone. It is nearly horizontal, and is slightly curved outwards.

In section the tube is first oblong, with its greatest diameter from top to bottom, then somewhat triangular, and finally oval, with its greatest diameter from side to side. It terminates in a slightly enlarged rounded extremity, flattened from top to bottom.

Comparison with Typical Mammals and Birds.

In general form the duckbill's cochlea closely resembles that of the bird, and is very different to the spiral cochlea of the ordinary mammal. The two first differ, however, in that the duckbill's is more curved, and curved outwards instead of inwards, as in the bird. The enlarged apex of the former is rounded, that of the bird oval. The typical mammalian cochlea tube differs from that of the duckbill, in being spiral instead of merely curved, in tapering from commencement to apex, and in being much longer. Lastly, the axis of the spiral cochlea is horizontal, whereas that of the curved one is vertical.

The Internal Arrangement and Minute Structure of the Duckbill's Cochlea.

The interior of the tube is divided horizontally into two scalæ by a partition, the inner portion of which is thick and bony (lamina ossea) ; the outer, thin and membranous (lamina membranacea) ; a third scala is formed by a delicate membrane (membrane of Reissner) proceeding from the upper surface of the lamina ossea to the inner* wall of the tube.

The upper and larger division is the scala vestibuli, and this communicates posteriorly with the vestibule ; the lower is the scala tympani. These two are united at the apex of the cochlea by means of an oval opening, helicotrema. The third, a small triangular tube, is the ductus cochleæ, or scala media, and this constitutes the membranous labyrinth ; it contains the endolymph, and is entirely separate from the other two scalæ, which contain the epilymph. The ductus cochleæ is lined with epithelium ; the scalæ vestibuli and tympani with endothelium.

The lamina ossea is a wedge-shaped mass of modified bone attached to the lower part of the outer wall and the outer part of the floor of the tube. Its inner free margin presents a deep groove (marginal sulcus), the lower lip of which projects further inwards than the upper. The lamina ossea does not extend to the apex of the cochlea, and thus allows of the communication between the scalæ vestibuli and tympani.

The ductus cochleæ is triangular in section, the floor is formed by the inner portion (limbus) of the lamina ossea and a strong membrane (membrana basilaris), which stretches from the lower lip of the sulcus to a mass of connective tissue (ligamentum cochleæ) adherent to the inner wall of the cochlea. The inner wall of the ductus is formed of this ligamentum cochleæ ; and the outer wall, or sloping roof, by the delicate membrane of Reissner, which springs from the upper surface

* In describing the position of the parts in the duckbill's cochlea, the median line of the body is taken as the centre ; in the spiral cochlea, the modiolus or axis.

of the limbus, and is attached to the upper part of the ligamentum cochleæ.

The membrana basilaris is composed of three fibrous layers; the lower, longitudinal; the middle, transverse; and the upper, formed of very fine transverse fibres. There are two blood-vessels running longitudinally in the lower layer.

The ligamentum cochleæ is a somewhat triangular mass of connective tissue with numerous blood-vessels, which in its upper portion run longitudinally, and, with the epithelium, form the stria vascularis.

The membrane of Reissner is composed of a delicate basement membrane, with the endothelium of the scala vestibuli on its upper surface, and epithelium on its under surface; here and there blood-vessels may be traced on it, running from the limbus to the ligament, and in some places these vessels form convoluted knots.

The epithelium lining the ductus cochleæ varies according to its position: that lining the membrane of Reissner is composed of a single layer of hexagonal cells; in the sulcus they are rounded; on the inner part of the membrana basilaris and the lower portion of the ligament they are cuboid; on the upper part of the ligament they are very peculiar, and resemble the transitional variety closely packed together. In the deeper part of the layer run numerous longitudinal blood-vessels, and this forms the already mentioned stria vascularis. The remaining portion of the epithelial layer that lies on the lower lip of the sulcus, and on the outer portion of the membrana basilaris, is developed into the so-called organ of Corti.

This organ of Corti consists of a double row of rods (of Corti), united at their upper ends and separate below; they stand on the membrana basilaris, and with it form a triangular tunnel.

The rods of both rows have cylindrical shafts and enlarged extremities; the upper ends of the inner row are rounded, and fit in corresponding concavities of the outer row. A delicate process projects inwards from the upper part of each of the rods, the processes of the outer ones lying above those of the inner.

Rows of hair cells are arranged on either side of these rods—one* to the outer side and three to the inner. Below the three inner rows are situated rows of nuclear cells (cells with well-marked nuclei, but no regular cell-wall), the cells of Deiters. Lying on the lower lip of the sulcus is a small mass of nuclear cells, and there is a row of these cells at each of the lower angles of the triangular tunnel.

The inner and outer side of the organ of Corti is formed of modified columnar cells. A reticulate membrane covers the rods and hair cells, the hairs of which project through certain circular meshes of the membrane.

* Since presenting this communication I have discovered a second row of hair cells in this position.

Covering the limbus, crossing the sulcus, and covering the organ, is a mucoid layer, the membrana tectoria.

Nerve filaments pierce the upper lip of the sulcus and pass to the hair cells and nuclear cells of the organ.

The organ of Corti, with the membrana basilaris below and the membrana tectoria above, form the lamina membranacea.

The ductus cochleæ commences as a delicate tube, no doubt connected in some way with the saccule of the vestibule. Its termination is very peculiar; instead of ending with the lamina ossea, where the organ of Corti ends, it is continued round the apex of the cochlea to form three-fourths of a circle. Just past the end of the lamina it forms a circular tube; at the other side of the apex, it enlarges into an oval chamber (lagena) which terminates at the base of the lamina ossea. This lagena is lined by epithelium, chiefly cuboid, but with one large patch of nerve epithelium, like the thorn cells and bristle cells found in the maculæ acusticæ of the vestibule. ("Quar. Jour. of Micros. Science," p. 379, 1876.)

The cochlear branch of the auditory nerve passes through the bone on a level with the floor of the tube, but to its outer side. It gives off lateral branches all along to the lamina, and its terminal fibres go to the lagena. The lateral branches pass through a ganglionic mass, similar to the ganglion spirale, and then on through the lamina, close to its lower surface, finally perforating the upper lip of the sulcus by a single row of holes (habenula perforata) and entering the organ of Corti as already described.

Comparison of the Minute Structure of the Cochlea of the Duckbill with that of Typical Mammals.

From the foregoing description, the duckbill's cochlea is shown to be so unmistakably mammalian in type, that merely the differences will here be noted.

The lamina spiralis membranacea increases in width, and so do its component parts, from base to apex of the spiral cochlea; in the duckbill's this widening takes place, but not nearly to such an extent as in the spiral cochlea.

The rods of Corti in the duckbill are not so well developed as in the typical mammal.

The membrane of Reissner in this monotreme presents blood-vessels on its surface with convoluted knots; these I have never found nor read of in this situation in any other mammal. The vas spirale of the ordinary mammal is represented by two vessels in the duckbill.

The course of the cochlear nerve necessarily differs in the two forms of cochlea.

But the great difference is found in the presence of the lagena at the

end of the duckbill's ductus cochleæ; this has never been found in mammals, but is found in birds, reptiles, and amphibians.

Comparison with the Bird.

A brief description of the bird's cochlea, will be found in my paper, *in extenso;* in this abstract I propose only noting the similarities and dissimilarities.

The scalæ tympani in each type of cochlea correspond.

There is no scala vestibuli in the bird, the scala media (ductus) occupying the whole of the upper division of the tube.

The membrane of Reissner and stria vascularis is represented by the tegumentum in the bird.

The lamina ossea corresponds to the quadrilateral cartilage, and the ligamentum cochleæ to the triangular cartilage of the bird.

There are no rods of Corti in the bird: the hair cells are more numerous and their component hairs are united together into a spine.

The nerve fibres pierce the quadrilateral cartilage by numerous rows of holes, instead of one row, as in the duckbill and other mammals.

The lagena, with its macula acustica, is found both in the bird and duckbill, but in the former is a direct continuation of the ductus, whereas in the latter it is connected by means of a constricted tube. Moreover, the ductus of the duckbill makes three-fourths of a turn, but that of the bird is nearly straight.

General Conclusions arrived at by the Research.

Although the outer form of this monotreme's cochlea resembles that of the bird in being nearly straight, yet its internal arrangement is decidedly mammalian.

The general acoustic apparatus of the duckbill's cochlea is not nearly so extensive as that of the ordinary mammal nor is its organ of Corti so well developed.

Lastly, the duckbill's cochlea possesses an addition, the lagena, which is not found in any other mammal, but which is found in the bird, reptile, and amphibian. Thus it presents a distinct link between the cochlea of the higher mammals and that of the lower vertebrates.

In conclusion, I desire to give my most hearty thanks to the many Australian friends who, by their zeal in my cause, have provided me with specimens of the ornithorhynchus in such a good state of preservation as to allow of their microscopic preparation and examination.